

# Changing Market Evaluation of Biotechnology Firms<sup>1</sup>

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**ABSTRACT.** The stock market's valuation of selected public firms within the biotechnology industry has been analyzed to measure the performance of specific companies within a subset of the industry and the performance of this subset of the biotechnology industry within a larger universe of publicly traded companies. The objective of the study was to analyze the performance of the individual firm into components attributable to 1) the overall performance of the economy; 2) the industry performance compared with other industries; and 3) the specific performance of the individual companies compared with other firms within the industry. The method of analysis is independent of conventional profit-and-loss approaches. The stock market alone is used for the evaluations. The changes in market value are the sum of the three components adjusted for the size of the firm.

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## INTRODUCTION

The usual method used to evaluate the financial performance of individual firms is to analyze operating statements and balance sheets. This conventional method of evaluation is not adequate for the case of early-entry firms in an industry based on new technologies (Office of Technology Assessment 1984a, 1984b). This is recognized in business periodicals by vague references to technology-driven industries as distinguished from profit-driven industries.

The purpose of this paper is to probe the changing market valuations of early-entry firms in biotechnology to develop a measurement system that will quantify individual performance, even if the companies are in a research mode with associated losses of substantial magnitude (U.S. Dept. of Commerce, International Trade Administration 1984). Most analysts assume that strong statements can be used to predict future positive changes in stock valuation. There is, of course, a correlation between strong financial data and future valuation by the market, but for companies losing money the logic that connects the variables is arcane.

## METHOD OF EVALUATION

The method for evaluation proposed in this paper is straightforward, and the logic is likewise direct. The market itself is used to evaluate the performance of individual firms. The change in a focal company valuation (denoted as size) by the market is decomposed into six terms: 1) a term for all-industry performance by a hypothetical firm of average size; 2) an adjustment to the all-industry first term to compensate for the actual size of the focal firm; 3) an industry-specific term for a hypothetical firm of average size in the industry; 4) an adjustment to the industry-specific term to allow for the difference in size of the focal firm from the average; 5) a firm-specific term for a hypothetical firm of average size; and 6) an adjustment to the firm-specific term to allow for the difference in size of the focal firm from the hypothetical average size firm. The difference in market valuation from one date to another is exactly accounted for by the six terms. The aggregate common stock valuation on a corresponding date is obtained by multiplying the number of outstanding shares by the closing value of shares traded (Data obtained from Standard and Poor's Daily Stock Price Record Over-The-Counter; Standard and Poor Corporation 1983, 1985).

## MATHEMATICAL RELATIONSHIPS

A relative rate of change,  $\dot{X}$ , is defined as follows:

$$\dot{X} = \frac{X_F - X_B}{X_B}$$

The starred symbol denotes the relative rate of change; the subscript  $F$  denotes the value of all outstanding common stock at the final time; and the subscript  $B$  denotes the value of all outstanding common stock at the base time. This expression is used with the understanding that the difference between the base time and the final time is fixed. In this study the time interval was two years.

Let  $X$  denote the value of a particular stock. The index of change is denoted as  $Z$ , and is the ratio of the value at the final time to the value at the base time. The index of change for that stock is therefore expressed as follows:

$$Z_X = \frac{X_F}{X_B}$$

The index of all-market valuation is defined as follows:

$$Z_N = \frac{N_F}{N_B}$$

The values for  $N_F$  and  $N_B$  are simply the Standard-and-Poor Composite Index values on the final date and the base date. Using the index concept eliminates the need for evaluating all stocks individually and summing for the base date and the final date.

The market valuation,  $e$ , for a focal firm (size) is the sum of the market valuation for a hypothetical firm of average size in the industry ( $b$ ) and the market valuation for the residual size ( $r$ ), or

$$e = b + r.$$

If the focal company valuation is greater than the average valuation,  $r$  is positive; if the company valuation is smaller than average, the residual,  $r$ , is negative. (Note that  $\Delta e = e\dot{e}$ . Also note that:

$$e\dot{N} = e \left( \frac{N_F - N_B}{N_B} \right)$$

$$e\dot{N} = e(Z_N - 1)$$

$$e\dot{N} = b(Z_N - 1) + r(Z_N - 1)$$

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Consider the diagram (Fig. 1) that indicates the relationship among rates of change.  $\dot{N}^*$  denotes the rate of change of the composite stock group;  $\dot{n}^*$  denotes the rate of change of the focal industry; and  $\dot{e}^*$  denotes the rate of change of the focal company. Thus,

$$\begin{aligned} e\dot{e}^* &= e\dot{N}^* + e(\dot{n}^* - \dot{N}^*) + e(\dot{e}^* - \dot{n}^*); \quad \text{and} \\ e\dot{e}^* &= e\dot{N}^* + b(\dot{n}^* - \dot{N}^*) + r(\dot{e}^* - \dot{n}^*) + b(\dot{e}^* - \dot{n}^*) \\ &\quad + r(\dot{e}^* - \dot{n}^*). \end{aligned}$$

The equation above is an identity. Each term consists of a size factor and a rate-of-change factor (Janson and Pavlakovic 1983, Janson et al. 1984). In the equation,

$$\begin{aligned} e\dot{e}^* &= b(Z_N - 1) + r(Z_N - 1) \\ &\quad + b(\dot{n}^* - \dot{N}^*) + r(\dot{n}^* - \dot{N}^*) \\ &\quad + b(\dot{e}^* - \dot{n}^*) + r(\dot{e}^* - \dot{n}^*), \end{aligned}$$

the change in valuation,  $e\dot{e}^*$ , is expressed as the sum of six terms. The terms with the factor  $b$  correspond to results for the focal firm, providing that the focal firm is of average size. If the firm is of average size, the residual value,  $r$ , is equal to zero. Also,  $b$  and  $Z_N$  and  $\dot{n}^*$  and  $\dot{N}^*$  are values that are the same for all companies in the industry. Only  $e$  is company-specific. Therefore, the fifth term is the term that measures company performance in comparison with other companies in the industry on an equal basis (i.e., for an equalized size  $b$ ). The value of the fifth term is an index of company performance within the industry.

The six terms can be arranged in a matrix as indicated in Figure 2. For an average size firm in the industry, all values in column  $r$  are equal to zero. For an average performing company within the industry,  $(\dot{e}^* - \dot{n}^*)$  is equal to zero. In this case terms 5 and 6 are equal to zero.

For a company of average size in the specified industry, operating with average industry performance, the contribution to growth is the sum of term 1 and term 3 (Fig. 2). Term 1 is the all-economy effect on an average size company. Term 5 is uniquely the accomplishment of the focal firm in a relative sense, because Term 5 presumes that the focal company is of average industry market value. Term 3 is an industry effect on an average size company. Terms 2, 4, and 6 correct for the specific size (market value) of the company.

If the company is smaller than average,  $r$  is negative. If the company performance is less than the industry average,  $(\dot{e}^* - \dot{n}^*)$  is also negative but the product is positive. Where growth rates are negative, a negative

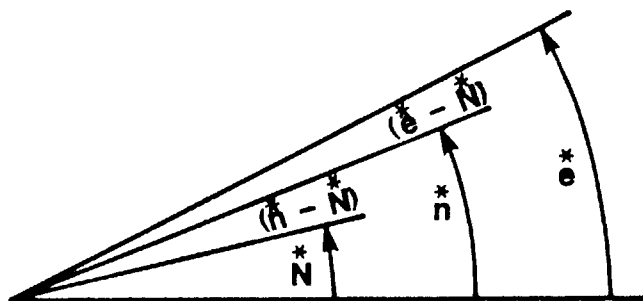


FIGURE 1. Market evaluation growth rates.  $\dot{N}^*$ ,  $\dot{n}^*$ , and  $\dot{e}^*$  denote the relative rates of change in the market evaluation for the composite stock group, industry group, and focal company, respectively. The variables are shown as slopes and differences in slopes.

		h	r	
		Average Size Factor	Residual Size Factor	Aggregate Size Factor
Demographic ( $Z_N - 1$ )	All-Industry Growth Factor	Term 1	Term 2	
Structural ( $n - N$ )	I-Industry Growth Factor	Term 3	Term 4	
Adaptive ( $\dot{e} - \dot{n}$ )	Company Growth Factor	Term 5	Term 6	
	Aggregate Growth Factor			$\Delta e = \Sigma 6 \text{ terms}$

FIGURE 2. Market evaluation matrix relating growth factors and size factors. Size refers to market value (shares outstanding  $\times$  market price);  $b$  refers to average size of a company within the  $i$ th industry;  $r$  refers to the difference in size from average for a focal company; starred symbols denote relative rates of change.  $Z$  denotes index of composite stock group;  $N$  denotes size of composite stock group;  $n$  denotes size of  $i$ th-industry stock group;  $e$  denotes size of focal company.

value for  $r$  mitigates the problem, because the algebraic product will be positive. This simply means that where growth rates are negative, the decline in market valuation would be exacerbated if the focal firm were larger than average ( $e > b$ ;  $r > 0$ ). If the firm is smaller than average ( $e < b$ ;  $r < 0$ ), the decline in market value will be less than for a firm of average size in market value. On the other hand, if the growth rate is positive, larger companies have better results than smaller ones. Only Term 5 allows a comparison among firms of the industry on an equal basis, and measures the specific company performance in the industry based on a hypothetical size equal to the industry average size.

## RESULTS AND DISCUSSION

Biotechnology companies present a serious problem of valuation. Of course, the market automatically adjusts the supply and demand for the stock, but the problem is one of evaluating the worth of a company that is typically suffering from substantial losses. The results, after a time, are incredible. For example, Biotechnica International had an equity per share of \$0.35 in April, 1986, with a bid price of \$8.50 and an asking price of \$9.00. At that time almost 4 million shares were outstanding, and about 50,000 shares traded monthly (Biotechnology News 1986). Substantial losses are continuing. This is not untypical. Investors are willing to pay great premiums in order to buy into biotechnology.

The change in valuation of a stock over time can be analyzed (decomposed) into three elements that correspond to the source of the impetus for change. First, part of the change in stock valuation is attributable to the larger securities market. In a "bull market" with heavy trading, all equities are influenced by the psychology of the general market. The physical assets and the proportion that is equity may not have changed at all, and yet the average market values of all equities are higher than before. Second, the industry component of the change in valuation reflects structural changes in the economy. In the long run, as the economy matures, per capita real income increases, and the percentage of income spent on

a commodity will change. For this reason, the structures of demand and production change. These are industry-wide influences on the valuation of a particular company's stock. For example, as an economy increases in wealth, the demand for products in saturated markets does not increase proportionately (Engle's Law). At the same time, the demand for innovative, high value-added products may increase more than proportionately. Finally, the variable company component of the change in stock valuations corresponds to the third source of the impetus for change. This component is firm-specific, and is assignable to individual company performance. Company-specific changes correspond to adaptations by the firm to the changing environment with results that may be better or worse than the adaptation by other firms in the same industry. For example, in the late 1970s, Chrysler responded more quickly than General Motors and Ford to the flood of imported Japanese cars by rapidly altering product lines to produce smaller models.

The three categories of influence are like forces; the valuation of the company corresponds to mass. When the company is larger than average, the effects are amplified. If the overall stock market reverses (measured by the Standard-and-Poor Composite Index), all constituent industry averages will decline. On the other hand, relative change among industry averages is primarily reflective of structural changes in patterns of commodity demand on one side of the economic problem and structural changes in technology and input proportions on the supply side of commodity production.

The findings have been tabulated (Table 1) for the 10 firms defined as a subset of the industry. Genentech was deliberately excluded from the study because its current transition from a research firm without major products to a pharmaceutical firm implies a different classification (see Olson 1986, Wagner 1984). Terms 1 and 2 (Fig. 2) have been added together (column 1 in Table 1) to present the general market expectation for the specified firm in the 1983-1985 stock market context. The data in Table 1 indicate that Cetus, Biogen, and Damon Biotech should be clear leaders, because they are the largest companies in a rising all-industry stock market.

The cell values in Term 5 are divorced from national, regional, and size effects (Table 1). Term 5 measures specific performance of the firm in a fair comparison, adjusted for a hypothetical average size. Cetus is the clear winner, with Immunex and Amgen also being strong performers. The dismal comparative performances of Genetic Engineering, Immuno Genetic, Gama, Molecular Genetic, and Damon Biotech were masked to a great extent by the general market movement and the industry performance.

Cetus was the overwhelming winner in increased market valuation during the two year period of 1984-1985, and investors were justified in their confidence. The large size of Cetus amplified its excellent performance. Biogen, Amgen, and, to a lesser extent, Immunex also had very substantial increases in market value. The increases in valuation of Immunex and Amgen were buttressed by excellent firm-specific performance. Both firms had a capitalization too small (less than average) to amplify their excellent performance. Immunex appears to be undervalued. This was the only company whose change in market value was less than its firm-specific contribution to the change.

## CONCLUSION

The method illustrated in this study allows comparative valuation of individual companies for an industry still in a research phase. Because the biotechnology industry is still in the formative stage of development, profits are usually non-existent, financial requirements are substantial, and disappointment is mixed with optimism. The ultimate products derived from research in biotechnology will be far-reaching and of great benefit to mankind. In the long term, methods of production using diverse biotechnologies will be used for chemical conversion, for plant and animal food production, and for health products. The capital requirements needed for this fledgling industry require analysis of individual company performance and potential. The method presented provides procedures to comparatively evaluate the performance of early-entry firms in an industry based on new technologies.

TABLE 1

*Composition of change in market value \*(millions of dollars) for 10 biotechnology firms, 1983-1985.*

*The equation for determining changes in market value is:*

$$b(Z_N - 1) + r(Z_N - 1) + b(\bar{n}^* - \bar{N}) + r(\bar{n}^* - \bar{N}) + b(\bar{e}^* - \bar{n}) + r(\bar{e}^* - \bar{n}) = \Delta \text{Market Value}$$

Firms	Terms 1 + 2	Term 3	Term 4	Term 5	Term 6	$\bar{e}^*$	1983 Value
Amgen	21.13	29.29	-4.39	28.40	-4.26	70.17	75.45
Biogen	55.12	29.29	35.68	-22.19	-27.03	70.87	196.87
Cetus	67.24	29.29	49.96	86.09	146.86	379.44	240.15
Damon Biotech	42.93	29.29	21.33	-52.36	-38.09	3.10	153.31
Gama	12.64	29.29	-14.39	-86.09	42.29	-16.26	45.15
Genetic Eng.	3.34	29.29	-25.35	-125.14	108.30	-9.56	11.94
Monoclonal Anti.	7.90	29.29	-19.98	6.21	-4.24	19.18	28.21
Immunex	10.46	29.29	-16.97	52.36	-30.33	44.81	37.34
Immuno Genetic	7.49	29.29	-20.46	-93.19	65.09	-11.78	26.76
Molecular Gen.	20.25	29.29	-5.43	-63.01	11.67	-7.23	72.31
Column Total	248.5	292.9	0	-268.90	270.26	542.74	887.49

\*Standard and Poor's Corporation (1983, 1985). Daily Stock Price Record Over-the-Counter (Oct., Nov., Dec.)

Average  
 $b = 88.75$

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